97 Origins of Species

READING

In Activity 92, "Time For Change," you saw that the types of living organisms have changed throughout Earth's history. Where do all of the new types of organisms come from?

CHALLENGE

What role do mutations play in natural selection?

MATERIALS

For each student

1 **Student Sheet 97.1, "Anticipation Guide: Origins of Species"**

Three different species of bears

READING

Use Student Sheet 97.1, "Anticipation Guide: Origins of Species," to prepare you for the reading.

Each species has a particular role within its ecosystem. The angelfish is adapted to eating small aquatic worms. To people, most adult angelfish of a particular breed appear the same: they are all of similar size and coloration and eat the same types of food. But there is some variation—every angelfish is slightly different (see photo left). Consider other organisms that you might think are identical. What could you do to identify differences among individuals within the species?

Variation Between Two Angelfish

One way to look for variation is to examine physical features, such as color and shape. Often, features like the width or pattern of stripes on an angelfish are slightly different from one fish to the next. Since some physical differences are due to genetic differences, they can be passed along through the generations.

STOPPING TO THINK 1

Think about similarities and differences among ten different people you know.

a. What are some physical features that are likely to be a result of genetic differences?

b. What are some physical features that may not be a result of genetics, but a result of some other factor(s), such as development from birth to adulthood?

c. What are some physical features that might be a result of both genetics and other factors?

In Activity 96, "Battling Beaks," you modeled a forkbird population that showed variation. Although all the forkbirds were from the same species, there were 1-tined, 2-tined, and 4-tined forkbirds. What was the source of these differences?

All genetic variation exists because of **mutations**. The reproduction of the genetic material does not always happen perfectly. As a result, occasionally an offspring has features that do not exist in the parents or even in the rest of the species. Some mutations are harmful. For example, a bird might be born with a beak of such unusual shape that the bird cannot feed. Such mutations are not passed on to the next generation, since the affected organism does not survive to reproduce.

In many cases, a mutation is neither helpful nor harmful. The 1-tined forkbird from the previous activity was an example of this type of mutation. Even though it was not as successful as the 4-tined mutation, the 1-tined beak was neither helpful nor harmful when compared to the 2-tined beak. Since there was no advantage or disadvantage to this type of beak, the 1-tined forkbird did not die out in the population.

STOPPING TO THINK 2

Imagine that you own a dog that recently gave birth to a litter of puppies. Your veterinarian informs you that one of the puppies has a genetic mutation.

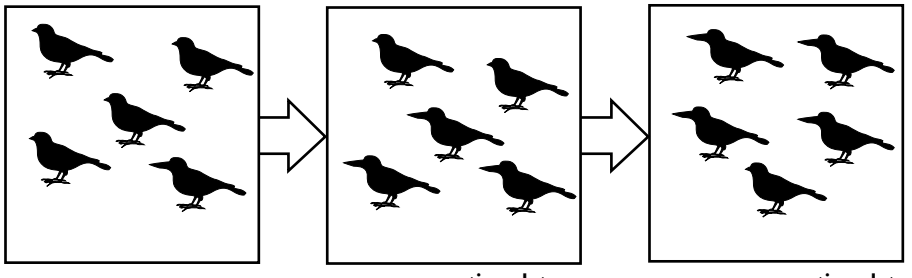
a. Think of a mutation that the puppy could have that would be neither helpful nor harmful.

b. Think of a mutation that the puppy could have that would be harmful.

In some cases, a mutation is helpful. Imagine that a bird from a species that eats small nuts is born with a larger beak than the rest of the population. The larger beak allows this bird to eat large nuts as well as smaller nuts. If nuts became harder to find, this mutation could help this bird survive and reproduce. Any larger-beaked offspring might continue to be more successful than the rest of the bird population. After many generations, all of these birds might have larger beaks (see figure below). In the previous activity, the 4-tined forkbird was an example of a helpful mutation.

EVOLUTION OF LARGER-BEAKED BIRDS

As a result of a helpful mutation occurring just once, an entire population of birds might look very different after many generations.



In a new environment, natural selection might favor a mutation that is not favorable in the original environment. If this population eventually can no longer successfully reproduce with the population it came from, it is considered a different species.

STOPPING TO THINK 3

You may have heard someone who is wrapping a present say, "I wish I had another hand!" Explain why an organism cannot choose to have a mutation that would enable it to live more successfully in its environment. For example, could birds choose to have larger beaks? Explain your reasoning.

THE GALAPAGOS

The fossil record provides evidence that many different species have lived during the history of Earth. But Charles Darwin was one of the first people to notice that living species also provide evidence for evolution. In the late 1830s, Darwin traveled on a ship called the *Beagle* that sailed around the world. He collected evidence and made careful observations of the natural world wherever the voyage took him. One of the places that the ship stopped was the Galapagos Islands, a chain of islands located in the Pacific Ocean, west of South America (shown at left).

In the Galapagos Islands, Darwin collected samples of many different species, including 14 species of finch (a small bird). All of the finches were similar, but the species varied in color, size, and beak shape. Darwin observed a relationship between the shape of a finch's beak and the food that it ate. Scientists had noticed that the beak of each species was particularly well-adapted to getting a specific type of food, such as a certain seed or insect (shown below).

A FEW GALAPAGOS FINCHES

Cactus finch

Large ground finch

Warbler finch

Based on his observations, Darwin hypothesized that all 14 different finch species had evolved from one single ancestral species. He proposed that, thousands or even millions of years ago, a single species of South American finch migrated and began nesting on the islands. Over many generations, different adaptations proved more successful on one island than on another. Because each island is separated by some distance from others in the chain, the finch population on each island is relatively small and isolated. This allowed helpful genetic mutations to spread within a population—by natural selection—more quickly than usual. Eventually, changes in beak shapes, combined with the spread of other helpful mutations, resulted in enough differences that the various finches became separate species, each adapted for a different ecosystem role.

Today, scientists use genetic evidence to compare similarities and differences among species. By testing the genes of the various finches, scientists have shown that the finches are very closely related, providing more evidence that Darwin's hypothesis is correct.

STOPPING TO THINK 4

Darwin identified 14 species of finch on the Galapagos Islands. Your friend says that this means only 14 mutations occurred within the finch populations. Explain whether you agree with your friend and why.

But you don't need isolated islands to produce new species. Remember the Nile perch of Lake Victoria in Africa, which you studied in the previous unit? One consequence of the introduction of these large fish into the lake was the extinction of up to 200 species of just one type of fish—the cichlid.

SPECIES OF CICHLIDS

How did so many species of the same fish family ever come to exist in a single lake? A single lake provides a surprising number of different places to live and ways to survive. Differences in the amount of light, wind, mud, sand, temperature, plants, predators, and insects produce a variety of habitats within one lake. Lake Victoria provides so many different habitats that over 300 different species of cichlids had evolved within the lake before the introduction of the Nile perch.

Are all of these cichlids really descended from a single ancestor? Every line of evidence suggests this is so. Modern genetic evidence indicates that all the cichlids in Lake Victoria evolved from a common ancestor within the last 200,000 years. That's a short period of time in terms of evolution!

ANALYSIS

1. Are mutations always helpful? Explain.
2. How can mutations enable the evolution of a new species to occur? Use the story of the cichlids to help you explain your ideas.
3. Under ideal conditions, bacteria have a generation time of about 20 minutes. Humans have a generation time of about 20 years. Which would you expect to evolve faster? Why?
4. Complete the "After" column of Student Sheet 97.1, "Anticipation Guide: Origins of Species." Did your thinking change?